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Effect of chitosan coating on postharvest quality of guava (*Psidium guajava* L.) Cv. Lucknow49

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Abstract
An experiment was conducted to study the effect of chitosan coating on the physical-chemical characteristics of guava *cv*. Lucknow 49 fruits stored at room temperature (28± 2 °C & 60 ± 10% RH) cumulative physiological loss in weight (CPLW) increased gradually in all the treatments with advancement of storage period. per cent increase in weight loss was recorded significantly low in 1.0% and 1.5% chitosan chitosan treated fruits were pre harvest spray with 2 per cent at MG stage. Postharvest treatment of chitosan at 1.5 per cent on fruits at colour turning stage recorded minimum PLW (%) than 1.0 per cent chitosan coating. The highest fruit weight loss was recorded in fruits which were not coated with chitosan irrespective of fruits being pre harvest sprayed with $Ca(NO3)_2$ at 1.0 and 2.0 *per cent*. Pre harvest spray with calcium nitrate (1 & 2%) and postharvest treatment of chitosan (1 & 1.5%) at mature green stage recorded maximum fruit firmness than at color turning stage. Significant differences were observed for the total sugar (%) and Total soluble solids (° Brix) in chitosan coating of fruits at MG and CT stage fruits from pre harvest spray at 1.0 and 2.0 per cent.

Keywords: Guava, postharvest, chitosan, mature green (MG) color turning (CT)

Introduction
Guava (*Psidium guajava* L.) is a fruit plant that belongs to the family of Myrtaceae. Guava is one of the most delicious and nutritious fruits, liked by the consumers for its refreshing taste and pleasant flavour. The fruit is high nutritional because its vitamin C content 50-300 mg/100g of fresh fruit (Mahajan *et al*., 2011) [30]. Due to its climacteric nature the fruit ripens rapidly and hence highly perishable, with a very short shelf life ranging from 2-3 days at room temperature. The fruit ripening in guava is characterized by loss of green colour, softening, shrinkage and loss of brightness rot development. Retailing of guava fruits in India is usually carried out under non-refrigerated conditions. Therefore preservation of fruits under ambient conditions is highly desirable in order to increase their shelf-life to facilitate long distance transportation, increase marketable period and thereby improving its commercialization.
Guava is a highly perishable fruit having high moisture content and intense metabolic activities which continues post-harvest, therefore loses its texture and quality during storage (Kanwal *et al*. 2016) [23]. Marketable life is also significantly limited by the abrupt softening during post-harvest handling. Therefore, guava fruits are required to be managed appropriately through judicious use of post-harvest treatments (Golding *et al*. 2005) [10]. The exogenous application of chemicals such as chitosan, $CaCl_2$, polyamines and gibberellins are being used to retard the physiological changes of the produce so as to increase the shelf-life. Chitosan is a high molecular weight cationic polysaccharide derived from a low acetyl form of chitin, mainly composed of glucosamine and N-acetylglucosamine with a β-1-4 glycosidic linkage (Hadwiger and McBride, 2006) [13]. Chitosan has great potentialities as a biodegradable, exhibits excellent biocompatibility, nontoxicity, antioxidant, antimicrobial activity (Zhelyazkov *et al*. 2014; Hussein *et al*. 2015) [41, 19] and also possesses film-forming and barrier properties (Elsabee and Abdou, 2013) [9], thus making it a potential raw material for coatings. It acts as an excellent semi-permeable barrier against oxygen, carbon dioxide and moisture, thereby reducing respiration and water loss and counteracting the dehydration and shrinkage of the fruit The objective of this research was to investigate the effect of chitosan on the physico-chemical characteristics of guava during storage.

Materials and Methods
The experiment was conducted to study the effect of chitosan (1 & 2%) coating on the physico-chemical characteristics of guava cv. Lucknow 49 fruits stored at room temperature

(28± 2 °C & 60 ± 10% RH) at Dept. of Postharvest Technology, HC&RI, TNAU, Periyakulam from 2020 to 2021. Preharvest spray with $Ca(NO_3)_2$ at 1.0 and 2.0 per cent (constant Treatment) was given and fruits were harvested at two different colour maturities at green mature stage (MG), and colour turning stage (green yellow-CT).Thereafter, the fruits were treated with chitosan (1% and 1.5%) to study its effect on the postharvest life and quality of guava under ambient storage condition. The chitosan (1&1.5%) treated fruits were then taken out, extra solution wiped off, air dried and were analyzed for physico-chemical parameters and then stored at room temperature. Samples were taken at two day interval until complete decay. All the observations were taken in triplicates.

Sample Treatment

Acetic acid (1%) solution was used to dissolve and prepare 1 and 2% chitosan. The solution was stirred for sufficient time using mechanical stirrer for complete dissolution of chitosan. Fruits were dipped in these chitosan solutions for 1-2 minutes, drained and surface dried (Rama Krishna, 2014) [34]. The physiological loss in weight (PLW) of fruit was calculated on initial weight basis and expressed in percent. Flesh firmness was measured by hand held fruit pressure tester penetrometer. Firmness of three fruits per treatment was measured and it was expressed in Kg cm^{-2}. Total soluble solids of juice was measured with the help of hand refractometer (0-32 ºBrix) and expressed as per cent soluble solids.

The titratable acidity was estimated by titrating against 0.1 N NaOH using phenolphthalein as an indicator (Ranganna, 2003) [35]. Appearance of pink colour was observed. From the volume of alkali used, acidity was calculated and expressed as g citric acid/100 g fruit pulp. Total sugars were estimated by the method of Sadasivam and Manickam, 1996 [37]. Color developed by anthrone reagent was measured at 625 nm against a reagent blank and concentration was calculated by preparing standard curve of glucose solution.

Color value

Color Changes during storage of fruits were observed using portable digital colorimeter (Display precision 0.01). Results were obtained as L* (lightness (51-100) and darkness (0-50), a* (a+ve indicates red whereas a-ve indicates green), b* (b+ve indicates yellow and b-ve indicates blue). Using these values, total color change (ΔE) was calculated using the formula (Rana *et al*., 2018 [34].

Statistical Analysis

The experiment was carried out in completely randomized design (CRD) with six treatments and four replications. The results obtained were subjected to analysis of variance (ANOVA) at $P< 0.05$ level of significance using AGRES software (Panse and Sukhatme, 1967) [35].

Results and Discussion

Pre harvest spray of calcium nitrate (1 & 2%) and postharvest treatment of chitosan coating on physiological loss in weight of guava cv. Lucknow 49 fruits at mature green stage (MG) and at colour turning stage (CT) during storage at ambient condition (27± 2°c and RH 60± 10%). Cumulative physiological loss in weight (CPLW) increased gradually in all the treatments with advancement of storage period. The treatment T_1 MG ($CaNO_3$- 1% + Chitosan-1%) recorded the weight loss of 1.15 on 1st day and15.56 per cent on the 9th day whereas T_2 MG ($CaNO_3$- 1%+ Chitosan-1.5%)recorded 1.87 per cent on the 1st day to17.44 per cent on 9th day after storage. The control treatment T_3 MG and T_6 MG recorded the maximum PLW of 2.47 to 18.09 and 2.78 to 18.76 per cent on 1st and 9th day after storage. Preharvest spray of Ca $(NO_3)_2$ at two per cent recorded minimum PLW (%) than Ca $(NO_3)_2$ at one per cent as preharvest spray. The postharvest treatment of chitosan coating at one per cent recorded the low PLW (%) followed by two per cent chitosan coating and significantly high in control (Table 1). Physiological loss in weight of postharvest treatment of chitosan coated fruits (1.0 & 1.5%) from preharvest spray with 1.0 per cent $Ca(NO_3)_2$ at color turning stage recorded 1.90 per cent on 1st day after storage to 23.28 per cent on 9th day after storage. The treatment T_2 CT recorded PLW of 2.42 to 20.31 per cent on 1st and 9th day after storage. The treatment T_4 CT maximum PLW of 15.22 per cent was recorded on seventh day after storage. (Table1)

The fruits from pre-harvest spray with two per cent calcium nitrate coated with postharvest treatment of 1.50 per cent chitosan (T_5 CT) recorded 2.92 per cent PLW on 1st day after storage and 19.30 per cent on 9th day after storage whereas, control (T_3 CT and T_6 CT) recorded maximum PLW of 15.18 and 10.27 per cent on fifth and fourth day after storage. The highest fruit weight loss recorded in fruits which was not coated with chitosan irrespective of fruits being preharvest spray with $Ca(NO_3)_2$ at 1.0 and 2.0 per cent, Postharvest treatment of chitosan at 1.5 per cent on fruits at color turning stage recorded minimum PLW (%) than 1.0 per cent chitosan (Table 2). Loss of weight in fruit is mainly due to respiration and chitosan coating act as barriers, thereby restricts evaporation, water transfer thus delays dehydration and maintains tissue rigidity (Krishna and Rao, 2014) [25]. Calcium plays an effective role in membrane functionality and integrity maintenance by binding to the polar head group of the phospholipids. Hence the lower loss of phospholipids with reduced ion leakage could be responsible for the lower weight loss in calcium treated fruits (Lester and Grusak, 1999) [26]. The reduction in weight loss in the guava fruit treated with chitosan is similar with the result in litchi (Lin *et al*. 2011) [28] and banana (Hossain and Iqbal, 2016) [16]. Apart from guava, chitosan has been effective in reducing weight loss in other fruits including strawberry (Hernandez- Munoz *et al*. 2008) [14], papaya (Ali *et al*. 2011) [1], mango (Chien *et al*. 2007) [2], mushroom (Jiang *et al*. 2012) [21], longan (Jiang and Li, 2001) [22] fruits. Dhillon and Kaur, 2013[6] reported that guava treated with 6% $CaCl_2$ recorded lowest weight loss as compared to the control.(Table 2)

Postharvest changes in quality of guava fruits cv. Lucknow 49 at mature green stage (MG) and at color turning stage (CT) after storage as influenced by different treatments. Considerable decrease in the fruit firmness was observed during storage of guava fruit irrespective of the treatment. Chitosan treatments delayed fruit softening and exhibited significant differences during storage. The maximum fruit firmness was recorded in T_1 MG (5.79kg/cm^2) followed by T_4 MG (5.65kg/cm^2) whereas, control recorded the firmness of 4.89kg/cm^2. Among the treatments T_2 CT recorded maximum fruit firmness of 4.92 kg/cm2 followed by 4.38 and 4.13 kg/cm^2 in T_1 CT and T_3 CT. The maintenance of fruit firmness in the fruits treated with chitosan could be due to their higher antifungal activity and covering of the cuticle and lenticels, thereby reducing infection, respiration and other ripening

processes during storage (Ali *et al*. 2005) [1]. These results with chitosan treatment were agreed with those observed in strawberries, raspberries, tomato, peaches, mango, papaya, guava (El Ghaouth *et al*. 1991 [7], 1992 [8]; Li and Yu, 2001 [27]; Zhu *et al*. 2008 [42]; Ali *et al*. 2011 [1]; Hong *et al*. 2012) [16]. Calcium plays major role in the retention of firmness fruits might be due to the calcium binding to free carboxyl groups of polygalacturonate polymer, stabilizing and strengthening the cell wall (Conway and Sams, 1983) [4]. Chitosan maintaining the structure of fruits as well as preharvest spray with Ca $(NO_3)_2$ might be because of interaction of calcium with pectic acid in cell walls to form calcium pectate, a compound helpful for maintaining structure of the fruit (Hussain *et al*. 2012) [18]. (Table 3 & 4).

There were no significant differences among the treatments for ascorbic acid content of the fruits. It ranged from 242.17 mg/100g at T_2 MG to 339.30 mg/100g in T_1 MG and maximum ascorbic acid content was recorded in T_2CT (280.02 mg/100g) followed by T_4CT (275.34 mg/100G), T_2 CT (280.02 mg/100g) Whereas control (T_3 CT and T_6 CT) recorded 253.50and 189.54mg/100g. Ascorbic acid is an essential attribute in judging fruit's antioxidant and reducing capacity. An initial increase in ascorbic acid could be due to availability of fruit sugar, a precursor of ascorbic acid synthesis but during later stages, oxidative destruction of ascorbic acid by oxidase might have contributed to decrease in ascorbic acid (Mapson, 1970 [31]; Singh *et al*. 2005) [36]. The higher level of ascorbic acid in chitosan treated fruit might reflect the low oxygen permeability, slowing down the respiration rate, which delays the deteriorative oxidation reaction of ascorbic acid of fruit. The present results of chitosan treatment are in conformity with the findings in mango (Jain and Mukherjee, 2011) [20], strawberries (Wang and Gao, 2013) [40] and kiwifruit (Huang *et al*. 2016) [17].

Significant differences were observed for the total sugar (%) and Total soluble solids (°Brix). The treatment T_5 MG recorded maximum total sugar and TSS of 8.60 per cent and 11.47 °Brix followed by T_2 MG (8.3% total sugar), T_1 MG and T_4 MG (8.10% total sugar and 11.33 and 11.04 °Brix) respectively. Control (T_3 MG and T_6 MG) recorded 6.40 and 5.85 per cent total sugar and TSS at 8.22 and 7.28 °Brix after storage whereas in color turning stage (CT) highest per cent of total sugar was observed in T_2 CT (7.70%) followed by T_1 CT(7.50%) and maximum TSS (°Brix) was recorded in T_1 CT (11.05 °Brix) followed by T_4 CT(10.34 °Brix). Lowest percent of total sugar and TSS (°Brix) was recorded in control (T_3 CT and T_6 CT) during the later storage period but it was maximum in the initial stage of ripening whereas, TSS and total sugar was minimum in fruits treated with chitosan as post harvest dipping (Table 3 & 4).

The initial increase in TSS content during storage might be due to hydrolysis of starch into sugars and subsequent declined due to the metabolism of sugars into organic acids during respiration The increase in TSS content was delayed in the fruits preharvest spray with calcium nitrate and postharvest treatment with chitosan. The delay in the rise of TSS content could be due to the slowing down of respiration and metabolic activity (Hong *et al*. 2012) [15]. A suppressing respiration rate also slows down the synthesis and the use of metabolites, resulting in lower TSS, due to the slower hydrolysis of carbohydrates to sugars (Das *et al*. 2013) [5]. The present experimental results are in close conformity with the findings of Kittur *et al*. (2001) [24] and Liu *et al*. (2014) [29], where a slow rise in TSS was recorded in mango, banana and plums treated with chitosan. The effect of calcium treatment on delaying the increase in TSS are in harmony with those reported by Sohail *et al*. (2015) [38] in peach fruit.

Colour value of the fruits treated with salicylic acid at 100 and 200 ppm stored under ambient condition recorded. The treatment T_1 MG samples darker (L=42.30), green (a = -7.66) and more yellow (b = 49.56). The delta values L, a and b (colour differences of the sample from standard value) showed that darker (ΔL = -2.09) Δa is -1.12 (green colour) and Δb = 3.96 (yellow colour) than standard value of L = 44.39, a = -8.78 and b = 45.60. The total colour difference ΔE = 4.62. The treatment sample T_2 MG recorded darker (L = 42.87) green colour (a = -8.17) and yellow colour (b = 49.04). The differences in colour showed that the darker (ΔL = -1.52) Δa is -0.61 (green colour) and Δb = 3.44(yellow colour).The treatment T_4 MG recorded minimum total color difference of ΔE =3.44 followed by T_2 MG (ΔE = 3.81) and T3 MG (ΔE = 4.16). In T4MG sample recorded lighter (L=43.12), green colour (a = -8.54), and yellow colour (b = 48.79). The colour difference is darker ((ΔL = -1.27), Δa is -0.24 (green color) and Δb = 3.19 (yellow colour). Fruits treated with EFF@ 2 per cent recorded that the colour value is lighter (L=43.71), green colour (a = -8.52) and yellow colour (b = 47.59) with colour difference is lighter ((ΔL0.68), Δa is -0.26 (green color) and Δb = (yellow color) and the total colour difference ΔE = 2.25 whereas the control treatment T_5 MG recorded maximum total colour difference ΔE = 10.16 (Table 5).

The treatment T_4 CT (color turning stage) recorded lighter (L = 45.31), green colour (a = -12.09) and yellow color (b = 46.03). The delta color differences L, a and b is darker (ΔL = -2.1) Δa is -0.75 (green colour) and Δb = 3.05 (yellow colour). The total colour difference is minimum (ΔE = 3.78) followed by T_2CT recorded ΔE = 4.65 and with L, a, b value is L = 44.32 (lighter), a = -11.69 (green colour) and b = 46.26 (yellow colour) and colour difference is (ΔL =-4.21) Δa is -1.41 (green colour) and Δb = 3.57(yellow colour) than the standard value (L=47.41,a=12.84 and b=42.98). The treatment T_5CT (Control) recorded maximum total colour difference of ΔE =11.14. Fruits treated with EFF at two per cent recorded the colour value is L=44.39 (lighter),a= -11.85 (green) and b=43.73 (yellow colour). The colour differences indicated that the darker (ΔL =-3.01) Δa is -0.43 (green colour) Δb = -3.75 (yellow colour) and ΔE =4.82 (Table 5& 6). L-value indicating brightness has increased gradually during storage from the day of harvest till the end of storage life. The negative a-value indicates greenness and positive a-indicates red colour. The gradual decrease of the negative value during storage indicates loss of greenness of fruit. The negative a-value decreased from date of harvest till the end of their storage life irrespective of the treatment. The 1.5% chitosan treated fruits lost greenness in minimum level, than 1% chitosan in both MG and CT stage. The positive b-value indicates yellowness and it increased from the day of harvest till the end of their storage life. The b-value increased from the day of harvest in both untreated and treated fruits, but the value is maximum at MG stage than CT stage. The colour change is a consequence of chlorophyll breakdown and formation of carotenoid pigments. The rate of loss of greenness and development of yellowness was slow in chitosan (both 1% and 1.5%) treated fruits compared to control fruits. This may be due to the reduction of respiration rate and lower metabolic activity in chitosan treated fruits.

The finding is agreed with the Varela *et al*. (2007) [39] stated that the ascorbic acid and calcium chloride treated minimally processed apples were found to maintain the lightness and chroma value during storage which is due to its radical scavenging activity and anti browning property. Chaibrando and Giacalone (2012) [3] also reported that the ascorbic acid, calcium chloride and citric acid were found to inhibit color change in apple cubes during cold storage for 5-10 days. Fresh cut pears treated with calcium chloride, calcium lactate and calcium propionate had maximum color retention than the control (Gomes *et al*., 2010) [12] Minimum total flesh colour difference (ΔE=1.39) and skin colour difference (ΔE=2.72) was recorded in sapota var. PKM1 treated with EFF at 0.50 per cent (Rajesh, 2020) [33]. Minimum (ΔE= 2.45 and 3.73) color change was observed in fruits treated with 1.0 and 0.5% ascorbic acid and 1.0% calcium chloride in jack varpalur 1 (Gomathi *et al*., 2021) [11].

Table 1: Effect of preharvest spray of calcium nitrate (1 & 2%) and postharvest treatment of chitosan coating on physiological loss in weight of guava cv. Lucknow 49 at mature green (MG) stage under ambient storage condition

Treatment	1 Day	2 Day	3 Day	4 Day	5 Day	6 Day	7 Day	8 Day	9 Day
T_1 MG- $CaNo_3$- 1%+ Chitosan-1%	1.15	3.02	4.95	6.63	8.17	10.04	11.88	13.72	15.56
T_2 MG- $CaNo_3$- 1%+ Chitosan-1.5%	1.87	4.02	6.33	8.57	9.56	11.23	13.63	15.27	17.44
T_3 MG- Control (Preharvest Spray 1%)	2.47	4.23	5.42	7.91	9.18	11.27	13.25	15.95	18.09
T_4 MG- $CaNo_3$- 2%+ Chitosan-1%	1.61	3.23	4.81	6.48	7.93	9.55	11.66	13.28	15.06
T_5 MG- $CaNo_3$- 2%+ Chitosan-1.5%	1.57	3.46	5.08	6.99	7.76	9.65	11.53	13.13	15.39
T_6 MG- Control (Preharvest Spray 2%)	2.78	4.19	7.22	8.75	10.49	12.25	14.95	17.23	18.76
Mean	1.91	3.69	5.63	7.55	8.85	10.67	12.82	14.76	16.72
SEd	0.515	0.663	0.786	0.679	0.560	0.644	0.672	0.728	0.990
CD (0.05)	NS	NS	NS	1.480	1.221	1.403	1.465	1.586	2.157

Table 2: Effect of preharvest spray of calcium nitrate (1 & 2%) and postharvest treatment of chitosan coating on physiological loss in weight of guava cv.Lucknow49fruits at colour turning stage (CT) during ambient storage condition

Treatment	1 Day	2 Day	3 Day	4 Day	5 Day	6 Day	7 Day	8 Day	9 Day
T_1 CT- $CaNo_3$- 1%+ Chitosan-1%	1.90	3.96	6.30	8.70	10.36	12.74	14.61	18.51	23.28
T_2 CT- $CaNo_3$- 1%+ Chitosan-1.5%	2.42	4.85	7.11	9.37	11.29	13.55	15.48	18.14	20.31
T_3 CT- Control (Preharvest Spray 1%)	3.00	5.25	7.43	10.29	15.18	0.00	0.00	0.00	0.00
T_4 CT- $CaNo_3$- 2%+ Chitosan-1%	2.53	4.89	6.77	8.94	10.35	13.20	15.22	0.00	0.00
T_5 CT- $CaNo_3$- 2%+ Chitosan-1.5%	2.92	4.95	6.98	9.53	10.94	13.60	15.65	17.16	19.30
T_6CT- Control (Preharvest Spray 2%)	3.17	5.46	8.60	10.27	0.00	0.00	0.00	0.00	0.00
Mean	2.66	4.89	7.20	9.52	9.69	8.85	10.16	8.97	10.48
SEd	0.390	0.505	0.665	0.918	0.716	1.082	1.137	0.759	0.904
CD (0.05)	NS	NS	NS	NS	1.560	2.358	2.477	1.655	1.971

Table 3: Postharvest changes in quality of Guava fruits cv. Lucknow 49 at mature green stage (MG) after storage at ambient condition

Treatments	Firmness (Kg/cm^2)	Ascorbic acid (mg/100g)	Total sugars (%)	Total soluble solids (^{0} Brix)
T_1 MG- $CaNo_3$- 1%+ Chitosan-1%	5.79	339.30	8.10	11.04
T_2 MG- $CaNo_3$- 1%+ Chitosan-1.5%	4.63	242.17	8.33	9.25
T_3 MG- Control (Preharvest Spray 1%)	4.89	307.56	6.40	8.22
T_4 MG- $CaNo_3$- 2%+ Chitosan-1%	5.65	310.44	8.10	11.33
T_5 MG- $CaNo_3$- 2%+ Chitosan-1.5%	4.32	306.54	8.60	11.47
T_6 MG- Control (Preharvest Spray 2%)	4.79	326.35	5.85	7.28
Mean	5.01	305.39	7.56	9.76
SEd	0.438	57.626	0.372	0.633
CD (0.05)	0.956	NS	0.812	1.379

Table 4: Postharvest changes in quality of Guava fruits cv. Lucknow 49 at color turning stage (CT) after storage at ambient condition

Treatments	Firmness (Kg/cm^2)	Ascorbic acid (mg/100g)	Total sugars (%)	Total soluble solids (^{0} Brix)
T_1 CT- $CaNo_3$- 1%+ Chitosan-1%	4.38	222.30	7.50	11.05
T_2 CT- $CaNo_3$- 1%+ Chitosan-1.5%	4.92	280.02	7.70	9.90
T_3 CT- Control(Preharvest Spray 1%)	4.13	253.50	6.17	6.37
T_4 CT- $CaNo_3$- 2%+ Chitosan-1%	3.84	275.34	5.66	10.34
T_5 CT- $CaNo_3$- 2%+ Chitosan-1.5%	4.19	269.88	6.93	9.64
T_6 CT- Control(Preharvest Spray 2%)	4.08	189.54	5.36	6.37
Mean	4.26	248.43	6.55	8.94
SEd	0.510	60.112	0.373	0.585
CD (0.05)	NS	NS	0.813	1.274

Table 5: Effect of postharvest treatment of chitosan at 1 &1.5 per cent on fruit skin color value of guava cv. Lucknow 49 fruits at mature green stage (MG) during storage at ambient condition

Treatments	L*	ΔL	a*	Δa	b*	Δb	ΔE*ab
T_1 MG - $CaNo_3$ 1% + Chitosan-1%	42.30	-2.09	-7.66	-1.12	49.56	3.96	4.62
T_2 MG - $CaNo_3$ 1% + Chitosan-1.5%	42.87	-1.52	-8.17	-0.61	49.04	3.44	3.81
T_3 MG - $CaNo_3$ 2% + Chitosan-1%	42.58	-1.81	-7.87	-0.91	49.23	3.63	4.16
T_4 MG - $CaNo_3$ 2% + Chitosan-1.5%	43.12	-1.27	-8.54	-0.24	48.79	3.19	3.44
T_5 MG - Control	35.44	-8.95	-7.12	-1.66	50.12	4.52	10.16

(Standard: L= 44.39, a*= - 8.78, b*= 45.60)

Table 6: Effect of postharvest treatment of chitosan at 1 &1.5 per cent on fruit skin color value of guava cv. Lucknow 49 fruits at color turning stage (CT) during storage at ambient condition

Treatments	L*	ΔL	a*	Δa	b*	Δb	ΔE*ab
T_1 CT - $CaNo_3$ 1% + Chitosan-1%	41.13	6.28	-11.13	-1.71	46.7	-3.72	7.50
T_2 CT - $CaNo_3$ 1% + Chitosan-1.5%	44.32	3.09	-11.69	-1.15	46.26	-3.28	4.65
T_3 CT- $CaNo_3$ 2% + Chitosan-1%	43.20	4.21	-11.43	-1.41	46.55	-3.57	5.70
T_4 CT - $CaNo_3$ 2% + Chitosan-1.5%	45.31	2.10	-12.09	-0.75	46.03	-3.05	3.78
T_5 CT- Control	37.89	9.52	-9.78	-3.06	47.90	-4.92	11.14

Standard: L= 47.41, a*= -12.84, b*= 42.98

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